

METHOD AND DEVICE FOR GENERATING TWO-DIMENSIONAL FLOOR PLANS

RELATED U.S. APPLICATION DATA

This application claims the benefit of US provisional application No. 60/430,584 filed on December 3, 2002.

TECHNICAL FIELD

[0001] The subject invention relates generally to the property management, building and construction industry, and more particularly to a novel method and device for mapping a building or other structure in two dimensions in order to generate digital floor plans.

BACKGROUND OF THE INVENTION

[0002] The original floor plans and architectural blueprints for a structure are often lost or unavailable to a building's owners. Even if the original documents are available, these documents may also contain significant deviations from the building "as built", due to renovations and other factors. Further, they may not be in a digital format, or are in a format no longer supported by existing software systems. In such cases, a labor and time intensive effort is needed to measure the data manually and generate new plans. The conventional method of using tape measurements is also inadequate because the level of accuracy is relatively poor.

[0003] An architect, renovator, property manager, appraiser or owner would prefer to avoid a costly and error-prone data entry process and generate, directly from the building, a two-dimensional floor plan of the structure as it currently exists.

[0004] To improve efficiency and accuracy, it is desirable to automatically record the measurements directly onto an electronic recording device and transfer the stored data to a computer for processing and generation of a finished plan in digital form. Several approaches have been proposed in the prior art, as described below.

[0005] U.S. Patent No. 4,205,385, issued to Erickson et al., describes a surveying system that provides automatic calculation and direct readout of various parameters and vectors encountered during a survey. It comprises a theodolite, a level sensor, and an on board microcomputer that can be used in conjunction with an electronic distance measuring instrument. The device translates raw data, comprising horizontal angle, vertical angle, and slope range, into the more useful component

vectors, horizontal distance, latitude, departure, and elevation. Measurements must be taken from a stationary traverse location that is fixed relative to the area or object being measured. The requirement of a stationary traverse location makes the measuring process tedious, time consuming, and expensive. Additionally, the user cannot view his work as it progresses for verification and correction, since this device does not operate as a real-time input device for a computer and associated applications software.

[0006] U.S. Patent No. 5,091,869, issued to Ingram et al., proposes a complex method for devising a floor plan comprising the selection of traverse points, the setting up of a surveying instrument on the traverse point and measuring distances and angles to prominent points on the floor. A further traverse point is then selected and the process repeated until all the data are collected. The data is then transferred to a separate computer and converted into a floor plan. The gathering of the data, according to Ingram et al., is a demanding operation that requires at least two persons.

[0007] It would thus be advantageous to provide a method and device that overcomes the drawbacks of the prior art. For example, it would be beneficial to provide an integrated device that enables a single operator to devise digital floor plan in a relatively short time.

[0008] U.S. Pat. No. 5,675,514, issued to Lefebvre, describes a spatial data recorder that is easy to use and can be manipulated by a single operator. The recorder has a base module and a remote module, which are linked through an extendable cable. The length and the angular orientation of the extendable cable are measured to determine the relative spatial position of the remote module with respect to the base module. With this spatial data recorder, the base module must be repositioned relatively often, which increases the time required to devise the plan of a floor. Furthermore, the use of an extendable cable between the modules may, in some instances, hinder the use of the system.

[0009] While the prior art methods can be used to produce a floor plan of a building, they are all variations of traditional surveying methods that successively measure point to point, using multiple steps and triangulation to create needlessly complicated two and three dimensional models from which a two dimensional floor plan is produced.

SUMMARY OF THE INVENTION

[0010] It is an object of the present invention to provide a novel device and method of creating two-dimensional floor plans which obviates or mitigates at least one disadvantage of the prior art.

[0011] According to a first aspect of the present invention, there is provided a method for generating a digital, two-dimensional floor plan for the exterior of an existing building. The method comprises drawing a first linear representation of a first object of a physical structure on the display screen of a portable computer using at least one input device, pointing at least one device that measures both distance and relative angles from the near corner position of said first object to the far corner position of said first object, transmitting said distance and angle to said portable computer, so that the length of the first linear representation can be adjusted to match an appropriate display scale, drawing a linear representation of a second object that is adjacent the first object, pointing said measuring device at the far corner position of said second adjacent object, to measure a new distance and angle, transmitting said second distance and angle to said portable computer so that the length of the second linear representation can be adjusted to match an appropriate display scale, and repeating the previous steps until the relative lengths and angles of every object of the structure is calculated and displayed onto a digital floor plan.

[0012] According to another aspect of the present invention, there is provided an apparatus for devising, on-site, a two dimensional floor plan from a physical structure, comprising a portable computer capable of running CAD software, at least one input device to manually sketch initial dimensions of objects within a physical structure onto a display screen of said computer, at least one portable device for measuring distances and angles between objects within a structure, means to transmit linear and angular measurements to said computer, and customized CAD software running on said computer that is configured to calculate an appropriate display scale to show on said screen, and to adjust the initial linear representations so that they conform to the calculated display scale, and to adjust the relative angles between objects based on the measurements received from said portable measuring device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Embodiments of the present invention will now be described, by way of example only, with reference to the attached Figures, wherein:

FIG. 1 is a perspective view of an integrated instrument that both records and generates digital floor plans;

FIG. 2 is a schematic block diagram of the connections between the various components

of the integrated instrument of FIG. 1;

FIG. 3 depicts the procedure for generating floor plans for exterior walls;

FIG. 4 depicts a schematic top plan view of a generic building, used in conjunction with the exterior floor plan procedure of FIG. 3; and

FIG. 5 through FIG. 8 depict schematic top plan views illustrating a simulation for generating floor plans for interior walls.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] FIG. 1 illustrates an instrument, denoted generally at 10 and constructed according to the invention, used to measure wall lengths in a building or structure in the example under consideration. In the FIG. 1 embodiment, the instrument 10 is held without any form of mechanical support. In this embodiment, the instrument 10 is small and light enough to be held with one person's arm, and consists of a thin, rectangular housing 15 that encloses a computer 20 and related operating system required to run a customized computer aided drafting (CAD) program. The upper surface of instrument 10 is substantially composed of a touch sensitive screen or pen tablet 25. Adjacent to the screen is an input device, which may include, but not restricted to, a stylus 30, mouse 32, and keyboard 34. A series of pre-programmed buttons 36 may also be included next to the screen, whose purpose will be explained shortly.

[0015] Also included with the instrument is a detachable, distance-measuring unit 50. Laser-based measurement units are common in the field, and include, for example, a handheld Leica Disto™ class 2 laser with accuracy of ± 3 mm or better. Since a laser beam consists of electromagnetic radiation traveling at the speed of light, very accurate measurements can be performed with this type of unit.

[0016] It is also pointed out that the distance-measuring device 50 of the instrument illustrated may also be designed in such a manner as to require the placement of reflectors on each measuring point. This embodiment would not be preferred because the measurement setup would be more complicated. Alternatively, mechanical or sonar type devices can also be used to measure distance.

[0017] As more clearly seen in FIG. 2, the distance-measuring unit 50 is outfitted with a data transfer device 55, preferably wireless-based, that allows the transfer of recorded data into the integrated computer via a receiver 40. Also included with said distance-measuring unit 50 is a measuring unit 60 that measures the relative angle between two surfaces, or other building features,

such as the angle between a wall and a column used in triangulation or an angle between a surface and a corner between another set of walls, again for triangulation purposes. The angle-measuring unit transmits said data via a data transfer device 65 to a receiver 40. Preferably, the angle-measuring unit is a gyroscope. Alternatively, a theodolite can be used.

[0018] The data transfer devices 55, 65 between the computer 30 (via receiver 40) and the distance and angle-measuring units, respectively, preferably operate in a wireless manner.

[0019] In a general mode of operation, the operator would first sketch out the floor plan of the structure of interest using one or more of the input devices 30, 32, and 34. Then, the distance-measuring unit and associated angle-measuring unit is removed and held by the operator in order to measure the dimensions of each room, as described below. The sequence of steps provided in the system and method of the invention are detailed in FIG. 3 and schematically illustrated in FIG. 4 through FIG. 8.

[0020] Ideally, the exterior floor plan is generated first. The instrument is set up outside the building to be measured, with small laser targets protruding slightly from each corner of the building. The targets do not need to be reflective in nature. Only one person is required to both measure dimensions and generate floor plans.

[0021] Alternatively, mechanical or sonar type devices can be used to measure distance in order to dispense with the need for reflectors or targets.

[0022] As a further alternative, if CAD drawings or other digital representations of the exterior top plan view exist, they can be imported into the customized CAD software and the separate procedure for generating the interior floor plan can be followed.

[0023] As illustrated in FIG. 3 and FIG. 4, the operator first draws one of the outside perimeter walls AB on the pen tablet screen 25 using at least one input device, such as a stylus 30. The wall type (e.g. straight, curved) is chosen from a choice of options in the associated computer software, accessible for example, by pressing one or more buttons 36, or from a selection of drop down menus incorporated in the CAD software. More simply, the wall type may be set to straight as the default by the CAD software. The operator then positions the detachable distance-measuring unit 50 at any first corner of the perimeter, shown as corner A in perimeter wall AB in FIG. 4. The laser beam is directed parallel to the wall AB and directly at the target protruding from corner B, so that the distance from corner A to corner B is measured. The associated angle-measuring unit 60 is set to a

zero reference angle. The data is transmitted to the computer and the CAD program adjusts the scale of the drawing displayed on the screen 25.

[0024] One of the adjoining walls, BC in the example, is then drawn on the screen 25. The operator then positions the measuring units 50, 60 at the junction of the first and second walls, corner B, and directs the laser to a target adjacent corner C to obtain an accurate reading for the length of the second wall BC, and the direction of wall BC relative to the first reference wall AB. In practice, this direction is usually close to 90 degrees. The relative distance and angle are transmitted to the computer and adjustments made to the sketched wall in proportion to the display scale.

[0025] Next, a third wall CD, adjoining the second wall BC, is drawn and the operator then directs the measuring units 50, 60 from the corner C to the far corner D, to obtain an accurate reading for the relative length and direction of the wall CD. The process is repeated around the entire perimeter of the house, setting the length with the distance-measuring unit 50 and the direction with the angle-measuring unit 60.

[0026] Referring now to FIG. 5 through FIG. 8, the use of the instrument for interior dimensions is illustrated to devise an interior floor plan having a plurality of walls. For each Figure, the plan is illustrated on the display screen 25, first as a sketch, then as a finished dimension once the distance and angle-measuring units 50, 60 are used to set the actual distance and direction between walls.

[0027] The operator first chooses one of the interior rooms in the corner as a starting point, labeled R1 in FIG. 5, and manually draws the two inside walls 101, 102 on the display device 25 using an input device, for example, a stylus 30. The wall type, in this example straight, is chosen by one of the pre-programmed buttons 36, or from a selection of drop down menus incorporated in the CAD software. More simply, the wall type may be set to straight as the default by the CAD software.

[0028] The other two walls, 103 and 104, form part of the exterior walls EF and FA, respectively, and are already defined in the CAD system from the previously determined exterior floor plan.

[0029] The operator then directs the detachable measuring units 50, 60 toward the actual interior corners to measure the relative lengths and directions. Ideally, the operator can start at one of the corners, for instance at the junction of walls 101 and 102, to directly measure the lengths of walls 101, 102 and indirectly measuring the lengths of walls 103 and 104 by triangulation. The lengths of

these walls can also be verified by direct measurement. The relative lengths and angles are transmitted to the computer and the CAD software adjusts the sketched lines accordingly.

[0030] Next, in FIG. 6, the operator draws openings, fixtures, stairwells and other features by selecting from drop down menus incorporated in the CAD software, or by pressing one of the pre-programmed buttons 36. The distance-measuring tool 50 can correct the positioning directly on the CAD drawing.

[0031] Next, in FIG. 7, the adjacent room R2 is sketched in by one or more input devices, including openings and other miscellaneous features. The measuring units 50, 60 are then used to correct for relative wall lengths and orientation, as in the same manner as previously described. The distances can be checked from the previous room, which eliminates the need to actually determine the wall thickness.

[0032] The previous step is repeated for each successive room, labeled as R3, R4, and R5 in FIG. 8. The distance-measuring unit can be used to measure overall dimensions as they become available, or to check against the anchor walls obtained from the exterior floor plan. When a particular room is finished, the CAD software prompts the operator to supply a name, and the room dimensions are then permanently stored onto the floor plan along with labels in digital format.

[0033] In all cases, the CAD system accepts relatively simple linear and angular input from the measuring units 50 and 60, respectively, and adjusts the distances and angles between linear representations displayed on a screen. Prior art systems measure absolute spatial data, usually in three dimensions, and transmit distances from the measuring unit to a base station. The applicant's disclosed system only transmits relative dimensions and angles and transforms initial linear representations into accurate scaled dimensions, never requiring a three-dimensional model. However additional "Z"-axis information such as ceiling heights, window heights, etc. are easily measured and recorded if the user so desires.

[0034] In a further embodiment, the instrument 10 also includes a GPS receiver, which allows the placement of a structure onto a street map, and a digital compass, which provides the orientation of a structure relative to magnetic north by placing and orienting a North Arrow on the plan relative to a predetermined direction such as the street-facing perimeter wall.

[0035] In another embodiment, a heads up screen and a virtual reality type control glove replaces the pen tablet 25 and input devices 30, 32, 34.

[0036] In yet another embodiment, measurement designation and other functions are controlled by voice recognition software.

[0037] In still another embodiment, the CAD program resides on a remote server, and the information is transmitted wirelessly to the central server and processed at the server in real time. This arrangement reduces the need for processing power on site and thus reduces the size and weight and the cost of the tablet computer, writing screen or heads up screen.

[0038] Although this invention has been described in conjunction with specific embodiments, many modifications and variations which do not depart from the scope of the invention, as defined by the attached claims, will be apparent to those skilled in the art.